24th RD50 Workshop (Bucharest)

Report of Contributions

https://indico.cern.ch/e/307015

Contribution ID: **0** Type: **not specified**

Studies of radiation damage in the LHCb Vertex Locator after Run I.

Friday, 13 June 2014 15:40 (20 minutes)

LHCb is a dedicated flavour physics experiment at the Large Hadron Collider at CERN. The Vertex Locator (VELO) is an important part of the LHCb tracking system, enabling precision measurements of beauty and charm mesons. It is the highest precision vertex detector at the LHC, featuring a single-hit resolution as good to 4μm.
The VELO comprises 42 silicon micro-strip modules. A module is made of two oxygenated n+-on-n 300 μm thick half-disc sensors with R-measuring and Phi-measuring micro-strip geometry, mounted on a carbon fibre support paddle. The minimum pitch is approximately 40 μm. The detector is also equipped with the only n-on-p sensors operating at the LHC.
The VELO operates in an extremely harsh radiation environment. A dose of 0.5 x 10ˆ14 1 MeV neutron equivalent /cm2 per fb-1 of data is predicted at the tip of the sensors.
Radiation damage of the VELO sensors is monitored using three independent methods: trending of leakage currents as a function of temperature, study of the charge collection efficiency, and noise measurements as a function of bias voltage.
This talk covers the results obtained using the first two methods. No significant performance degradation after the Run I data taking period has been observed. The observed effects related to radiation damage are in agreement with expectations.

Primary authors: ON BEHALF OF THE LHCB VELO GROUP, . (.); OBLAKOWSKA-MUCHA, Agnieszka (AGH University of Science and Technology (PL))

Presenters: ON BEHALF OF THE LHCB VELO GROUP, . (.); OBLAKOWSKA-MUCHA, Agnieszka (AGH University of Science and Technology (PL))

Session Classification: Session

Contribution ID: **1** Type: **not specified**

Trapping in p-on-n silicon sensors at fluences relevant for the HL-LHC

Thursday, 12 June 2014 10:00 (20 minutes)

Effective trapping rates in 200 um thick n-type silicon sensors are determined after irradiation of up to 3 x 10¹⁵ neq/cm2 for electrons and holes.

For this pulsed red laser light with a wavelength of 672 nm is used to generate electron-hole pairs close the the electrodes of single-pad sensors (diodes).
The charge-collection efficiencies were determined separately for electrons and for holes drifting through the sensor, and they were used to extract the effective trapping rates by comparing the results to simulations.

The electric field was simulated in Synopsys TCAD device simulations assuming two effective defects. Different literature values for the defect concentrations and the cross sections were used for low-energy protons (23 MeV) and high-energy protons (23 GeV). The generation and the drift of charge carriers were simulated in an independent simulation based on PixelAV.

The effective trapping rates which describe the measured charge-collection efficiencies were determined and simulated and measured time-resolved current pulses have been compared.

The trapping rates determined for both electrons and holes are about 50% lower compared to often-used extrapolations of earlier studies which were done at lower fluences. Hence an improved tracker performance is predicted.

Primary author: POEHLSEN, Thomas (University of Hamburg)

Presenter: POEHLSEN, Thomas (University of Hamburg)

Session Classification: Session 3 - TCAD simulations

Contribution ID: **2** Type: **not specified**

Investigation of point and extended defects in electron irradiated silicon –dependence on the particle energy

Wednesday, 11 June 2014 09:10 (20 minutes)

Silicon samples of n-type have been irradiated with electrons in the range 1.5 –27 MeV and different fluences. The Mott cross section as function of silicon recoils kinetic energy revealed that the threshold for the production of cluster related defects is 1.2 keV. For the characterization of the radiation induced defects the Thermally Stimulated Current (TSC) and Deep Level Transient Spectroscopy (DLTS) methods were used. From DLTS studies the impact of the V3 and E205a defects on the leakage current was confirmed, whereas from the TSC studies the contribution of the E(30K), H(40K), Ip and H defects to the Neff is shown.
The annealing kinetics of the H defects was studied in detail by performing isothermal annealing for temperatures higher than 200 0C. From the Arrhenius plot of ln(1/τ) versus 1000/T the activation energy for the annealing out process of the H defect, for DOFZ and STFZ samples, are calculated. The obtained results will be presented and discussed.

Primary author: RADU, Roxana (National Institute of Materials Physics NIMP, Bucharest, Romania)

Co-authors: FRETWURST, Eckhart (Institute for Experimental Physics, Hamburg University, Hamburg, Germany); LINDSTROEM, Gunnar (Institute for Experimental Physics, Hamburg University, Hamburg, Germany); Dr PINTILIE, Ioana (National Institute of Materials Physics NIMP, Bucharest, Romania)

Presenter: RADU, Roxana (National Institute of Materials Physics NIMP, Bucharest, Romania)

Session Classification: Session 1 - Defect and Material Characterization

Contribution ID: **3** Type: **not specified**

Heavily irradiated thin n-in-p planar pixel sensors and status of the new common RD50 productions

Wednesday, 11 June 2014 15:20 (20 minutes)

N-in-p planar pixel sensors with an active thickness of 200 μm produced at CiS, and 100-200 μm thin active/slim edge sensor devices, produced at VTT in Finland have been interconnected to ATLAS FE-I3 and FE-I4 read-out chips and irradiated in Ljubljana, Los Alamos and KIT up to a fluence of 1.4×10ˆ{16} n_{eq}/cmˆ2.
Thin sensors are designed to ensure radiation hardness at high fluences, while the active edge technology of the VTT production maximizes the sensitive area of the assembly.
Hit efficiency and charge collection results after irradiation obtained with radioactive sources in the laboratory and with high precision measurements at beam tests are presented and compared for different thicknesses and active edge designs.
We also introduce the new productions of p-type FZ silicon sensors on 6 inch wafers co-funded by RD50 including 50, 100 and 150 μm thin active edge structures produced at ADVACAM and 270 μm thick wafers produced at CiS.

Primary authors: MACCHIOLO, Anna (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D); PASCHEN, Botho Albrecht (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D); TERZO, Stefano (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D)

Co-author: Dr NISIUS, Richard (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D)

Presenter: TERZO, Stefano (Max-Planck-Institut fuer Physik (Werner-Heisenberg-Institut) (D)

Session Classification: Session 2 - Detector Characterization

Contribution ID: **4** Type: **not specified**

A_{Si}-Si_i defect as possible origin of electronically activated degradation of boron and indium doped silicon

Wednesday, 11 June 2014 09:50 (20 minutes)

New possibilities in the field of silicon characterization (low-temperature PL spectroscopy and low-temperature FTIR) at CiS are presented.
Furthermore recent results on investigations regarding a defect, which appears due to electron or photon injection and degrades the charge carrier lifetime in boron doped silicon, are shown. The defect is known since the 1970s. First it was found to appear after electron irradiation of n-in-p silicon solar cells for space applications. Later the degradation effect was detected in as grown Czochralski silicon as well. This defect will possibly impact n-in-p radiation detectors, too. A defect model based on A_{Si}-Si_i (A stands for B or In) is presented and discussed with regard to the observed defect properties.

Primary author: Dr LAUER, Kevin (CiS Forschungsinstitut für Mikrosensorik und Photovoltaik GmbH)

Co-authors: MÖLLER, Christian (CiS Forschungsinstitut für Mikrosensorik und Photovoltaik GmbH); RÖDER, Ralf (CiS Forschungsinstitut für Mikrosensorik und Photovoltaik GmbH); Dr WITTIG, Tobias (CiS Forschungsinstitut für Mikrosensorik und Photovoltaik GmbH)

Presenter: Dr LAUER, Kevin (CiS Forschungsinstitut für Mikrosensorik und Photovoltaik GmbH)

Session Classification: Session 1 - Defect and Material Characterization

Contribution ID: **5** Type: **not specified**

Modelling Vacancy-Interstitial Clusters and their effect on on Carrier Transport in Silicon

Wednesday, 11 June 2014 11:00 (20 minutes)

High energy particle bombarding creates both point defects and clusters of defects within the target material. We model such a cluster of defects in silicon crystal as a few nanometer size region of randomly displaced ions which may be understood also as an aggregate of vacancy and interstitial defects. The electronic states within the cluster and its environment are calculated using density functional method. The results of calculations performed on 25 randomly created clusters exhibit the presence of deep level states within the silicon band gap. These localized states originate mainly from the broken interatomic valency bonds. Further structure relaxation of cluster modelled by the same density functional theory calculations and in practice realized as annealing lead either to restoration of ordered crystal structure or to formation of more energetically stable cluster of vacancy and interstitial defects. In the last case the great part of broken bonds are reconnected and the number of deep level states is diminished. The remaining deep level states act as acceptors of the conduction band electrons. After being charged by the captured electrons these acceptors highly concentrated within the cluster create an electrostatic potential substantial enough to modify the transport of charge carriers. This in turn leads to modification of voltamperic characteristics of silicon semiconductor structures and devices.
To model the macroscopic effect of cluster defects introduced into semiconductor device we use the Synopsys TCAD software tools. We show that the defect clusters modify conduction properties of silicon sample. The electrostatic potential barriers created by randomly distributed clusters prevent the free carrier movement and the conductivity of the sample is greatly reduced. However if the electric field of the applied external voltage is stronger than the one of these microscopic potentials the defect clusters have no effect and the conductivity of the sample is restored.

Primary author: Dr ZASINAS, Ernestas (Vilnius University)

Co-author: Prof. VAITKUS, Juozas (Vilnius University)

Presenter: Dr ZASINAS, Ernestas (Vilnius University)

Session Classification: Session 1 - Defect and Material Characterization

Contribution ID: **6** Type: **not specified**

Edge-TCT studies of non-irradiated HVCMOS sensors

Thursday, 12 June 2014 11:20 (20 minutes)

A HVCMOS sensor (HVCMOS2FEI4) was investigated before the irradiation with Edge-TCT. Key properties of the charge collection in p substrate were determined by different analysis methods. Good agreement between the measured and given substrate resistivity was found. The measurements revealed that the major contribution to the measured charge comes from the movement of carriers by diffusion and only a fraction from the drift. The drift component increases with applied bias voltage and reaches around 30% at 60V. Charge collection measurements from Edge-TCT were also compared to 90Sr measurements.

Primary author: KRAMBERGER, Gregor (Jozef Stefan Institute (SI))

Co-authors: LA ROSA, Alessandro (Universite de Geneve (CH)); ROZANOV, Alexandre (CPPM, Aix-Marseille Université, CNRS/IN2P3 (FR)); Dr BLUE, Andrew (University of Glasgow); MIUCCI, Antonio (Universite de Geneve (CH)); QUADT, Arnulf (Georg-August-Universitaet Goettingen (DE)); RISTIC, Branislav (Universite de Geneve (CH)); KREIDL, Christian (Heidelberg University); BUTTAR, Craig (University of Glasgow (GB)); HYNDS, Daniel (University of Glasgow); MUENSTERMANN, Daniel (Universite de Geneve (CH)); FERRERE, Didier (Universite de Geneve (CH)); HUEGGING, Fabian (University of Bonn); BOMPARD, Frederic (Centre National de la Recherche Scientifique (FR)); IACOBUCCI, Giuseppe (Universite de Geneve (CH)); KRUEGER, Hans (University of Bonn); PERNEGGER, Heinz (CERN); MANDIC, Igor (Jozef Stefan Institute (SI)); PERIC, Ivan (Ruprecht-Karls-Universitaet Heidelberg (DE)); WEINGARTEN, Jens (Georg-August-Universitaet Goettingen (DE)); GROSSE-KNETTER, Joern (Georg-August-Universitaet Goettingen (DE)); RIEGER, Julia Katharina (Georg-August-Universitaet Goettingen (DE)); BACKHAUS, Malte (CERN); CAPEANS GARRIDO, Mar (CERN); MIKUZ, Marko (Jozef Stefan Institute (SI)); Dr ZAVRTANIK, Marko (Jozef Stefan Institute (SI)); BARBERO, Marlon B. (CPPM - CNRS/IN2P3 / Aix-Marseille Université (FR)); NESSI, Marzio (CERN); GEORGE, Matthias Alexander (Georg-August-Universitaet Goettingen (DE)); GARCIA-SCIVERES, Mauricio (Lawrence Berkeley National Lab. (US)); WERMES, Norbert (Universitaet Bonn (DE)); BREUGNON, Patrick (Centre National de la Recherche Scientifique (FR)); PANGAUD, Patrick (Centre National de la Recherche Scientifique (FR)); BATES, Richard (University of Glasgow (GB)); GONZALEZ SEVILLA, Sergio (Universite de Geneve (CH)); FEIGL, Simon (CERN); OBERMANN, Theresa (Universitaet Bonn (DE)); HEMPEREK, Tomasz (Universitaet Bonn (DE)); CINDRO, Vladimir (Jozef Stefan Institute (SI))

Presenter: KRAMBERGER, Gregor (Jozef Stefan Institute (SI))

Session Classification: Session 3 - TCAD simulations

Contribution ID: **7** Type: **not specified**

Beam test of thin epitaxial silicon strip sensors for the CMS phase II pixel upgrade

Friday, 13 June 2014 14:00 (20 minutes)

The high luminosity upgrade of the Large Hadron Collider (HL-LHC) foreseen for 2022 will allow the experiments at the collider to collect data at a luminosity of 5×10^{34} cm^{-2}s^{-1}, enhancing the discovery potential for new physics. The precise determination of vertices in the high radiation environment close to the HL-LHC interaction points demands the development of solid state detectors that can withstand unprecedented fluences.

The CMS experiment strategy to overcome this challenge consists in the replacement of the whole tracking system, the so-called phase II tracker upgrade. The innermost layers of the upgraded pixel detector will experience fluences in the order of $_{eq}$ 10^{16} cm^{-2} after an integrated luminosity of 3000 fb^{-1}. Several options are under investigation to provide a material and a design still operational after such fluences. Thin planar silicon sensors are candidates to achieve this goal since they show a less severe degradation of the charge collection efficiency with irradiation than thicker devices.

The University of Hamburg and DESY are carrying on the characterization of highly irradiated epitaxial silicon sensors with an active thickness of 100 µm. The investigation includes diodes and strip detectors irradiated up to a fluence of $_{eq} = 1.3\times10^{16}$ cm^{-2}. In order to extract the charge collection properties of the strip sensors, a test beam campaign has been carried out at the DESY II test beam facility. A beam telescope has been used to determine precisely the impact position of beam particles on the sensor. This allows an unbiased measurement of the charge collected by the strip sensor and reduces the effects of the noise.

In this talk the first results of the test beam campaign are presented.

Primary authors: JUNKES, Alexandra (Hamburg University (DE)); ECKSTEIN, Doris (DESY); CENTIS VIGNALI, Matteo (Hamburg University (DE)); EICHHORN, Thomas (DESY)

Co-authors: GARUTTI, Erika (DESY); Dr STEINBRUECK, Georg (Hamburg University (DE)); POEHLSEN, Thomas (University of Hamburg)

Presenter: CENTIS VIGNALI, Matteo (Hamburg University (DE))

Session Classification: Session

Contribution ID: **8** Type: **not specified**

Electron Induced Damage in Silicon - TRIM and TCAS Simulations

Wednesday, 11 June 2014 10:10 (20 minutes)

The maximum Si-recoil energy is strongly dependent on the electron energy, reaching values at e.g. 30 MeV, which are also specific for MeV neutron irradiation. A systematic investigation of the damage on the electron energy could therefore reveal a tool to distinguish between point and cluster effects, see report given ba Roxana Radu. Supporting calculations are presented here. Recoil energy distributions are calculated from Mott scattering and displacement cascades simulated using TRIM and Crystal-TCAS. Details are presented including intracascade recombinations. Results are discussed and compared with currently used damage functions.

Primary author: Prof. LINDSTROEM, Gunnar (University of Hamburg)

Presenter: Prof. LINDSTROEM, Gunnar (University of Hamburg)

Session Classification: Session 1 - Defect and Material Characterization

Contribution ID: **9** Type: **not specified**

CCE and Edge_TCT measurements with ATLAS 07 and ATLAS 12 detectors

Wednesday, 11 June 2014 14:40 (20 minutes)

CCE efficiencies of two detector batches were measured before and after irradiations with neutrons and protons to fluences up to 5 10**15 cm-2. Annealing was performed at 60 C. Edge TCT measurements were used to probe the drift velocity distribution in the detector volume.

Primary author: MANDIC, Igor (Jozef Stefan Institute (SI))

Co-authors: KRAMBERGER, Gregor (Jozef Stefan Institute (SI)); MIKUZ, Marko (Jozef Stefan Institute (SI)); Dr ZAVRTANIK, Marko (Jozef Stefan Institute (SI)); CINDRO, Vladimir (Jozef Stefan Institute (SI))

Presenter: CINDRO, Vladimir (Jozef Stefan Institute (SI))

Session Classification: Session 2 - Detector Characterization

Contribution ID: **10** Type: **not specified**

Lorentz angle measurement on ATLAS silicon microstrip sensors

Thursday, 12 June 2014 11:00 (20 minutes)

The Large Hadron Collider (LHC) is planned to be upgraded to High-Luminosity LHC (HL-LHC) by 2023. At the same time, the ATLAS inner tracker will be replaced by an all silicon tracker. During HL-LHC running, strip detectors in the inner tracker will have to withstand radiation doses up to $10^{15} neq/cm^{-2}$. As a result of the radiation damage, the Lorentz angle of the strip sensors is expected to change. In this talk, a test beam setup prepared to measure the Lorentz angle on highly irradiated future ATLAS silicon microstrip sensors will be presented. In this setup, an Alibava readout system and the EUDET beam telescope is used. In addition, Alibava data analysis tools are being implemented in the EUTelescope framework and will be introduced in this talk.

Primary author: YILDIRIM, Eda (Deutsches Elektronen-Synchrotron (DE))

Co-authors: GREGOR, Ingrid-Maria (DESY); TACKMANN, Kerstin (Deutsches Elektronen-Synchrotron (DE))

Presenter: YILDIRIM, Eda (Deutsches Elektronen-Synchrotron (DE))

Session Classification: Session 3 - TCAD simulations

Contribution ID: **11** Type: **not specified**

Status of Silicon Strip Sensor Measurements at Liverpool

Wednesday, 11 June 2014 15:00 (20 minutes)

To investigate the current dependence of irradiated silicon strip detectors, ATLAS07 and Micron sensors were irradiated at Birmingham and Ljubljana with doses up to 2e16 neq/cm^2. IV measurements were performed at different temperatures which allow the calculation of the effective gap energy Eg (IV scaling) and the current related damage rate α.

TCT and edge TCT (Transient Current Technique) measurements with red and IR laser of dedicated RD50 charge multiplication sensors allow a deeper investigation of charge collection. The multiplication sensors, produced by Micron Semiconductor Ltd (UK) and irradiated at fluences of 1e15 neq/cm^2 and 5e15 neq/cm^2, feature many different structures specially designed to take advantage of multiplication after heavy irradiation.

Primary author: WONSAK, Sven (University of Liverpool (GB))

Co-authors: GALLRAPP, Christian (CERN); BETANCOURT, Christopher (Albert-Ludwigs-Universitaet Freiburg (DE)); FORSHAW, Dean Charles (University of Liverpool (GB)); CASSE, Gianluigi (University of Liverpool (GB)); NEUGEBAUER, Hannes (Hamburg University (DE)); JAKOBS, Karl (Albert-Ludwigs-Universitaet Freiburg (DE)); HAUSER, Marc Manuel (Albert-Ludwigs-Universitaet Freiburg (DE)); FERNANDEZ GARCIA, Marcos (Universidad de Cantabria (ES)); MOLL, Michael (CERN); DERVAN, Paul (University of Liverpool (GB)); Dr KODYS, Peter (Charles University); MORI, Riccardo (Albert-Ludwigs-Universitaet Freiburg (DE)); KUEHN, Susanne (Albert-Ludwigs-Universitaet Freiburg (DE)); PARZEFALL, Ulrich (Albert-Ludwigs-Universitaet Freiburg (DE))

Presenter: WONSAK, Sven (University of Liverpool (GB))

Session Classification: Session 2 - Detector Characterization

Contribution ID: **12** Type: **not specified**

Radiation hardness of Low Gain Amplification Detectors (LGAD)

Friday, 13 June 2014 09:00 (20 minutes)

Silicon n-p diodes with heavily doped p layer underneath the n implant were designed to benefit from charge multiplication process already before irradiation (Low Gain Amplification Detectors). Two different sets of such detectors with different gains were characterized before and after irradiation by reactor neutrons and recently also by 800 MeV protons to equivalent fluences of up to 1016 cm-2. The devices were studied by different techniques; CV, IV, TCT and signal measurements from 90Sr source. The gain, which was initially up to 10, was found to decrease with neutron fluence. The main reason for this seems to be the decrease of effective doping concentration in the highly doped p layer leading to decrease of electric field strength. The conclusions drawn from the measurements were also reproduced in simulation.

Primary author: KRAMBERGER, Gregor (Jozef Stefan Institute (SI))

Co-authors: PELLEGRINI, Giulio (Universidad de Valencia (ES)); SADROZINSKI, Hartmut (SCIPP, UC santa Cruz); MANDIC, Igor (Jozef Stefan Institute (SI)); MIKUZ, Marko (Jozef Stefan Institute (SI)); Dr ZAVRTANIK, Marko (Jozef Stefan Institute (SI)); BASELGA BACARDIT, Marta (Instituto de Fisica Corpuscular (ES)); HIDALGO VILLENA, Salvador (Universidad de Valencia (ES)); FADEYEV, Vitaliy (University of California,Santa Cruz (US)); CINDRO, Vladimir (Jozef Stefan Institute (SI))

Presenter: KRAMBERGER, Gregor (Jozef Stefan Institute (SI))

Session Classification: Session 4 - Sensors with intrinsic gain - LGAD

Contribution ID: **13** Type: **not specified**

TCT, eTCT and I-DLTS measurement setups at the CERN SSD Lab

Wednesday, 11 June 2014 14:20 (20 minutes)

Setups based on the transient current technique using pulsed LASERs with 660nm and 1064nm wavelength were built at the CERN SSD Lab.

Microsecond LASER pulses are used in the I-DLTS setup to investigate charge carrier detrapping on irradiated silicon sensors. First measurement results from a set of proton irradiated silicon diodes exposed to red laser pulses of 1us to 5us are presented.

A new TCT+ setup based on the former TCT setup combines all features of a conventional red and IR TCT measurement with an edge-TCT setup. A temperature controlled Peltier cooling system allows measurements above -20C with a variation of +-0.4C. A summary of measurements performed with irradiated and unirradiated samples illustrates the current state of the system.

Primary author: GALLRAPP, Christian (CERN)

Co-authors: NEUGEBAUER, Hannes (Hamburg University (DE)); FERNANDEZ GARCIA, Marcos (Universidad de Cantabria (ES)); MOLL, Michael (CERN)

Presenter: GALLRAPP, Christian (CERN)

Session Classification: Session 2 - Detector Characterization

Contribution ID: **14** Type: **not specified**

Measurement of the drift velocities of electrons and holes in high-ohmic <100> silicon

Wednesday, 11 June 2014 14:00 (20 minutes)

Simulations of silicon sensors and extraction of parameters from (edge-)TCT measurements rely on the knowledge of a number of material parameters. One of them is the drift velocity for electrons and holes as function of electric field and temperature in high-purity silicon. So far the information on drift velocities for <100> silicon is quite limited. Therefore, <111> results are typically also used for the analysis of <100> data.

Measurements of the drift velocity of electrons and holes in high purity n- and p-type silicon of <100> orientation are presented. The drift velocity is determined from current transients (TCT) of silicon pad diodes using two different methods: the well-established time-of-flight method and the fit of simulated current transients to measured transients. The measurements cover electric field values between 2.5 kV/cm and 50 kV/cm and temperatures between 233 K and 333 K.

We also introduce a parameterization of the dependence of the drift velocities on electric field and temperature, which differs from the standard one [Jacoboni], and which provides a good description of the literature data and our results.

For both electrons and holes differences of more than 15 % are found between the <100> and literature <111> drift velocities. For electrons, the <100> results reflect previous measurements. However, for holes differences of 5 to 15 % are observed for fields above 10 kV/cm. The use of the results presented will improve the accuracy of simulations and analyses of sensors fabricated with <100> silicon, especially in the high field region.

Primary author: SCHARF, Christian (Hamburg University (DE))

Co-authors: GARUTTI, Erika (DESY); SCHWANDT, Joern (Uni Hamburg); Prof. KLANNER, Robert (Hamburg University (DE))

Presenter: SCHARF, Christian (Hamburg University (DE))

Session Classification: Session 2 - Detector Characterization

Contribution ID: **15** Type: **not specified**

Workshop opening

Wednesday, 11 June 2014 09:05 (5 minutes)

Presenters: Dr PINTILIE, Ioana (NIMP Bucharest-Magurele, Romania); MOLL, Michael (CERN)

Session Classification: Session 1 - Defect and Material Characterization

Contribution ID: **16** Type: **not specified**

Timing properties of UFSD

Friday, 13 June 2014 10:00 (20 minutes)

In this contribution I review the progress towards the optimization of LGAD detectors for timing measurements. First results will be presented, together with a plan for additional measurements

Primary author: Mr CARTIGLIA, Nicolo (Universita e INFN (IT))

Co-authors: SEIDEN, Abraham (University of California,Santa Cruz (US)); RAVERA, Fabio (Universita e INFN (IT)); CENNA, Francesca (Universita e INFN (IT)); SADROZINSKI, Hartmut (SCIPP, UC santa Cruz); SPENCER, Ned (University of California,Santa Cruz (US))

Presenter: Mr CARTIGLIA, Nicolo (Universita e INFN (IT))

Session Classification: Session 4 - Sensors with intrinsic gain - LGAD

Contribution ID: **17** Type: **not specified**

Evaluation of the Low Resistance Strip Sensors Fabricated at CNM

Friday, 13 June 2014 15:20 (20 minutes)

Results from the second batch of Low-R strip sensors fabricated at CNM-Barcelona will be presented. This second batch implements several technological and design changes in order to correct the PTP structure, not fully functional in the first batch. The tests on the newly fabricated sensors show good general performance plus a correct behaviour of the PTP structure. The results from the laser tests show the proper limitation on the strip voltage in the event of a beam-loss even when the change injection is produced far from the PTP structure for the Low-R strip sensors. This strip voltage limitation is not seen for the standard sensors also fabricated in the same wafer. This demonstrates the effectiveness of the proposed low resistance strip. Finally, alternative technological implementations for the Low-R sensors will be presented. These solutions are in fabrication at the moment at CNM.

Primary author: Dr ULLAN COMES, Miguel (Instituto de Fisica Corpuscular (ES))

Co-authors: Dr GRILLO, Alex (University of California,Santa Cruz (US)); LACASTA LLACER, Carlos (IFIC-Valencia); PELLEGRINI, Giulio (Universidad de Valencia (ES)); SADROZINSKI, Hartmut (SCIPP, UC santa Cruz); LOZANO FANTOBA, Manuel (Instituto de Fisica Corpuscular (ES)); BENITEZ CASMA, Victor Hugo (Instituto de Fisica Corpuscular (ES)); FADEYEV, Vitaliy (University of California,Santa Cruz (US))

Presenter: Dr ULLAN COMES, Miguel (Instituto de Fisica Corpuscular (ES))

Session Classification: Session

Contribution ID: **18** Type: **not specified**

Effect of background impurities and electronic excitation on the behavior of radiation induced interstitial boron complexes

Wednesday, 11 June 2014 09:30 (20 minutes)

New experimental data have been presented on substitutional boron removal under irradiation and its restoration under thermal and recombination annealing in epitaxial Si structures.

Primary author: MAKARENKO, Leonid (B)

Co-authors: Dr PINTILIE, Ioana (NIMP Bucharest-Magurele, Romania); MOLL, Michael (CERN); Dr LASTOVSKII, Stanislav (Scientific-Practical Materials Research Centre of NAS of Belarus)

Presenter: MAKARENKO, Leonid (B)

Session Classification: Session 1 - Defect and Material Characterization

Contribution ID: **19** Type: **not specified**

Segmented LGAD

Friday, 13 June 2014 09:20 (20 minutes)

Our experience with segmented LGAD is presented, based on
charge collection data, C-V measurements and simulations.
Alternatives to the present n++-p+-p- configuration are discussed.

Primary author: SADROZINSKI, Hartmut (SCIPP, UC santa Cruz)

Co-authors: SEIDEN, Abraham (University of California,Santa Cruz (US)); ZATSERKLYANIY, Andriy (UC Santa Cruz); PARKER, Colin (UC Santa Cruz); BASELGA BACARDIT, Marta (Instituto de Fisica Corpuscular (ES)); CARTIGLIA, Nicolo (Universita e INFN (IT)); FREEMAN, Patrick (UC Santa Cruz); FADEYEV, Vitaliy (University of California,Santa Cruz (US)); GALLOWAY, Zac (UC Santa Cruz); Dr LIANG, Zhijun (University of California,Santa Cruz (US))

Presenter: SADROZINSKI, Hartmut (SCIPP, UC santa Cruz)

Session Classification: Session 4 - Sensors with intrinsic gain - LGAD

Contribution ID: **20** Type: **not specified**

A method to model the accumulation of oxide charge with fluence in an irradiated MSSD

Thursday, 12 June 2014 09:20 (20 minutes)

Measurements have shown a significant position dependency of CCE for charged hadron irradiated MSSDs. When this is reproduced by Synopsys TCAD simulation using non-uniform 3-level defect model (R. Eber tuned proton model supplemented by shallow acceptor level close to detector surface) the phenomenon is seen to be dependent of the concentration of the shallow acceptors and the oxide charge at the SiO2/Si interface.
By monitoring the CCE loss between the strips for fluences 3e14 and 1.5e15 n_eq cm-2 in a real detector, the simulation opens up a possibility to model (at least qualitatively) the accumulation of the oxide charge as a function of fluence. If one of the two open parameters can be fixed, the simulation can also provide accurate quantitative information of the other.
Comparison of simulations with measurements from the Silicon Beam Telescope (SiBT) will be presented.

Primary author: PELTOLA, Timo Hannu Tapani (Helsinki Institute of Physics (FI))

Co-authors: HAERKOENEN, Jasu (Helsinki Institute of Physics (FI)); MAEENPAEAE, Teppo (Helsinki Institute of Physics (FI))

Presenter: PELTOLA, Timo Hannu Tapani (Helsinki Institute of Physics (FI))

Session Classification: Session 3 - TCAD simulations

Contribution ID: **22** Type: **not specified**

Fabrication of 200um thick p and n- type pad detectors with enhanced multi-plication effect

Friday, 13 June 2014 09:40 (20 minutes)

I will show the final design of the new mask for the fabrication of LGAD diodes, strips and pixel detectors.

Primary author: PELLEGRINI, Giulio (CNM-IMB-CSIC)

Presenter: PELLEGRINI, Giulio (CNM-IMB-CSIC)

Session Classification: Session 4 - Sensors with intrinsic gain - LGAD

Contribution ID: **23** Type: **not specified**

Discussion: Defect and Material Characterization

Wednesday, 11 June 2014 12:00 (30 minutes)

Presenter: Dr PINTILIE, Ioana (NIMP Bucharest-Magurele, Romania)

Session Classification: Session 1 - Defect and Material Characterization

Contribution ID: **24** Type: **not specified**

Preliminary results on proton irradiated LGAD PAD detectors

Friday, 13 June 2014 11:00 (20 minutes)

We will present the latest measurements of LGAD diodes performed with TCT laser (red and infra-red) and the preliminary measurements of LGAD PAD detectors irradiated with protons at Los Alamos.

Primary author: Dr GRECO, Virginia (IMB-CNM-CSIC)

Co-authors: PELLEGRINI, Giulio (Centro Nacional de Microelectrónica (IMB-CNM-CSIC) (ES)); FERNÁNDEZ-MARTÍNEZ, Pablo (IMB-CNM-CSIC); HIDALGO VILLENA, Salvador (Universidad de Valencia (ES))

Presenter: Dr GRECO, Virginia (IMB-CNM-CSIC)

Session Classification: Session 4 - Sensors with intrinsic gain - LGAD

Contribution ID: **25** Type: **not specified**

A Long Term Study of Charge Multiplication

Friday, 13 June 2014 11:20 (20 minutes)

We evaluate the long term evolution of the charge multiplication effect found in some sensors. This procedure is intended to test operation under realistic LHC conditions, such as exposure to extreme bias voltages for many days, bias voltage cycling, and running at very low temperature. We aim to understand if charge multiplication may be usefully relied upon for HL-HLC operation, or if it turns out to be a short-term benefit.

Primary author: PARZEFALL, Ulrich (Albert-Ludwigs-Universitaet Freiburg (DE))

Co-authors: BETANCOURT, Christopher (Albert-Ludwigs-Universitaet Freiburg (DE)); JAKOBS, Karl (Albert-Ludwigs-Universitaet Freiburg (DE)); LOHWASSER, Kristin (Deutsches Elektronen-Synchrotron (DE)); MORI, Riccardo (Albert-Ludwigs-Universitaet Freiburg (DE)); KUEHN, Susanne (Albert-Ludwigs-Universitaet Freiburg (DE))

Presenter: PARZEFALL, Ulrich (Albert-Ludwigs-Universitaet Freiburg (DE))

Session Classification: Session 4 - Sensors with intrinsic gain - LGAD

Contribution ID: **26** Type: **not specified**

Simulations of Hadron Irradiation Effects for Si Sensors Using Effective Bulk Damage Model

Thursday, 12 June 2014 09:40 (20 minutes)

In order to address the expected radiation damage problems in the future generations of colliders, there have been constant efforts to understand the basic mechanism of radiation damage and its effects on the Si sensor properties. Extensive studies based on device measurements and performance simulations have been carried out. Despite these efforts, many interesting problem remain unsolved or sometime, are not tacked properly. For example, peculiar behavior of 1/C2 curves for irradiated diodes have not been explained properly, the meaning of full depletion voltage can be given differently for different bulk damage model.
In the present work, device simulations have been carried out for n+-in-p and p+-in-n of sensors using effective bulk damage model. It has been shown that a coherent interpretation of various sensor properties like leakage current, full depletion voltage and charge collection efficiency simulations can be achieved. The absolute value of full depletion voltage can be very useful in extracting the information about electric fields inside the Si sensor. Further, it will be shown that observed donor removal and acceptor removal effects can be interpreted in terms of double junction effect.

Primary author: RANJEET, Ranjeet (University of Delhi (IN))

Co-authors: BHARDWAJ, Ashutosh (University of Delhi (IN)); Ms JAIN, Geetika (University of Delhi); Mr NEUGEBAUER, Hannes (CERN); RANJAN, Kirti (University of Delhi (IN)); MOLL, Michael (CERN)

Presenter: RANJEET, Ranjeet (University of Delhi (IN))

Session Classification: Session 3 - TCAD simulations

Contribution ID: **27** Type: **not specified**

ESR investigation of paramagnetic point defects in O doped crystalline Si-FZ irradiated with 27 MeV electrons

Wednesday, 11 June 2014 11:20 (20 minutes)

The presence and nature of the paramagnetic point defects produced in single crystalline samples of high resistivity (3-4 kOhm cm) n-type silicon (FZ- Wacker), doped with 17O enriched isotope, after irradiation with 27MeV electrons (2 x 1016 cm-2), has been investigated by Q-band (34 GHz) electron spin resonance (ESR) spectroscopy in the 10- 296 K temperature range. Changes in the nature and concentration of the paramagentic centers observed before and after in-situ 637 nm optically excitation have been further observed following subsequent isochronal annealing from 150 0C up to 300 0C in steps of 50 degrees. A tentative comparison with thermally stimulated currents (TSC) data on such samples subjected to similar irradiation and thermal tratments is also presented.

Primary author: NISTOR, S.V. (NIMP - Magurele (RO))

Co-author: Dr PINTILIE, Ioana (NIMP Bucharest-Magurele, Romania)

Presenter: NISTOR, S.V. (NIMP - Magurele (RO))

Session Classification: Session 1 - Defect and Material Characterization

Contribution ID: **28** Type: **not specified**

High resolution transmission electron microscopy (HRTEM) investigations of silicon irradiated with high energy electrons

Wednesday, 11 June 2014 11:40 (20 minutes)

The formation and evolution of extended defects following irradiation with 15 and 27 MeV electrons and further thermal annealing treatments have been observed by HRTEM on a high resolution analytical JEOL ARM 200F electron microscope. Clusters of point defects (vacancies and interstitials) with dimensions smaller than 3 nm are observed subsequent to irradiation. Their density increases with the energy of irradiated electrons. By thermal annealing at low temperatures (80oC), they start to agglomerate into extended planar defects lying in the {111} planes in the case of vacancies aggregations, or the {113} planes for the aggregation of interstitials. Their dimensions are in the range of 5-7 nm. Further annealing at 200 oC results in an increase in the density of the {113} interstitial-type defects, but not in their average dimension. Annealing at 270 oC produces an apparent decrease of the extended defects concentration.

Primary author: NISTOR, Leona (NIMP Bucharest-Magurele (RO))

Co-author: Dr PINTILIE, Ioana (NIMP Bucharest-Magurele, Romania)

Presenter: NISTOR, Leona (NIMP Bucharest-Magurele (RO))

Session Classification: Session 1 - Defect and Material Characterization

Contribution ID: **29** Type: **not specified**

Slim-edge and non-uniformly irradiated 3D silicon pixel detectors for forward physics experiments

Friday, 13 June 2014 14:40 (20 minutes)

The ATLAS Forward Physics (AFP) project plans to install 3D silicon pixel detectors 210 m away from the interaction point and very close to the beamline at a radius of about 2-3 mm. This implies the need of slim edges in the order of 100 µm for the sensor side facing the beam to minimise the dead area. Another challenge is an expected non-uniform irradiation of the pixel sensors with high radiation levels of about 5e15 neq/cm2 for the detector edge close to the beam and orders of magnitude lower radiation levels for the detector part away from the beam.

To study if these requirements can be met using slightly-modified IBL FE-I4 3D pixel sensors, standard IBL devices are diced to obtain slim edges and are irradiated with 23 MeV protons non-uniformly through an Aluminium mask. The performance was studied with test beams and source scans. The efficiency in the irradiated region was found to be similar to the one in the non-irradiated region except for the transition area between both, where a much lower efficiency was seen. A follow-up study for a position-resolved fluence monitoring was set up to check whether this effect can be explained by a possibly higher effective fluence at the edge of the Aluminium mask.

Primary author: LANGE, Joern (IFAE Barcelona)

Co-authors: CAVALLARO, Emanuele (IFAE Barcelona (ES)); LOPEZ PAZ, Ivan (Universitat Autònoma de Barcelona (ES)); GRINSTEIN, Sebastian (IFAE/ICREA Barcelona)

Presenter: LANGE, Joern (IFAE Barcelona)

Session Classification: Session

Contribution ID: **30** Type: **not specified**

SiMS measurements & Simulation, Varied bias rail geometry structures characterization and TCAD simulation

Thursday, 12 June 2014 09:00 (20 minutes)

Secondary Ion Mass Spectroscopy measurements, conducted to calibrate the new edgeless pixel production for the High Luminosity upgrade of the LHC, are being compared with TCAD simulated doping profiles for n and p implanted wafers. On the same context, simulation and characterization of varied bias rail geometry structures is being presented in an attempt to understand and compensate for the efficiency drop issue under the biasing gird region. Through 3D profile and field simulation, the structures under investigation are being compared with experimental measurements.

Primary author: GKOUGKOUSIS, Vagelis (Universite de Paris-Sud 11 (FR))

Co-authors: LOUNIS, Abdenour (Universite de Paris-Sud 11 (FR)); NELLIST, Clara (LAL-Orsay (FR)); DINU, nicoleta

Presenter: GKOUGKOUSIS, Vagelis (Universite de Paris-Sud 11 (FR))

Session Classification: Session 3 - TCAD simulations

Contribution ID: **31** Type: **not specified**

Discussion on LGAD

Friday, 13 June 2014 11:40 (40 minutes)

Presenter: GRECO, Virginia (Instituto de Fisica Corpuscular (ES))

Session Classification: Session 4 - Sensors with intrinsic gain - LGAD

Contribution ID: **32** Type: **not specified**

Status of the new irradiation facilities in the CERN EAST HALL

Wednesday, 11 June 2014 15:40 (20 minutes)

The proton and mixed-field irradiation facilities in the CERN PS East Area (known as IRRAD1 and IRRAD2), were heavily and successfully exploited for irradiation of particle detectors, electronic components and materials since 1992. These facilities exploited the particle bursts - protons with momentum of 24GeV/c - delivered from the PS accelerator in "spills"of about 400ms (slow extraction). With the increasing demand of irradiation experiments, these facilities suffered from a number of unpleasant restrictions such as the space availability, the maximum achievable particle flux and several access constraints. In the framework of the AIDA project, an upgrade of these facilities was proposed based on the assumption that the DIRAC experiment will be completed by the end of 2012 and its experimental apparatus dismounted in the CERN long shutdown during 2013-2014. The new East Area Irradiation facility (EA-IRRAD) would then be installed in the area occupied by the DIRAC experiment. The proposal being accepted, the construction project of the new facilities has begun in November 2012. The facilities are now expected to be ready for commissioning during summer 2014. While the new proton facility (IRRAD) will continue to be mainly devoted to the radiation hardness studies for the experimental community, the new mixed-field facility (CHARM) will mainly host irradiation experiments for the validation of electronic systems used in accelerator underground areas such at the LHC. In this paper, we outline the characteristics of the new proton irradiation facility (IRRAD) in terms of layout, area equipment and potential for new irradiation experiments.

Primary author: MOLL, Michael (CERN)

Co-authors: GKOTSE, Blerina (N); Dr RAVOTTI, Federico (CERN); GLASER, Maurice (CERN); LIMA DA COSTA E SILVA, Pedro Miguel (CERN)

Presenter: MOLL, Michael (CERN)

Session Classification: Session 2 - Detector Characterization

Contribution ID: **33** Type: **not specified**

Characterisation and testing of ATLAS FE-I4 devices for the HL-LHC

Friday, 13 June 2014 14:20 (20 minutes)

The LHC accelerator complex will be upgraded in 2022 to the High-Luminosity-LHC in order to significantly increase statistics for the various physics analyses. These modifications will result in an increase in occupancy and of radiation damage to the ATLAS Inner Detector.

Characterisation and testing in a laboratory environment of novel ATLAS planar pixel designs for the HL-LHC will be presented, including charge collection measurements with radioactive sources and cosmic muons. Non-perpendicular particle tracks, forming clusters of charge within the pixel devices, have been studied. The characterisation and testing facilities (laser and sources) will be used for irradiated samples.

Primary author: NELLIST, Clara (LAL-Orsay (FR))

Co-authors: LOUNIS, Abdenour (Universite de Paris-Sud 11 (FR)); Dr DINU, Nicoleta (Universite de Paris-Sud 11 (FR)); GKOUGKOUSIS, Vagelis (Universite de Paris-Sud 11 (FR))

Presenter: NELLIST, Clara (LAL-Orsay (FR))

Session Classification: Session

Contribution ID: **34** Type: **not specified**

Investigation of radiation hardness of alumina layer for slim edge devices

Friday, 13 June 2014 15:00 (20 minutes)

We have been investigating Scribe-Cleave-Passivate (SCP) method of making slim edges on silicon sensors. For n-type devices commonly used dielectrics, such as silicon oxide and nitride, work well and they are radiation resistant. For p-type devices we used alumina (Al2O3) for this purpose. Our earlier radiation tests revealed its potential weakness for low ionizing doses. In this work we have made dedicated MOS structures with alumina and irradiated them with gammas and protons. The structures allow a direct evaluation of interface charge on the border of alumina and silicon, which is important for the SCP slim edge performance. We obtained first results indicating development of the interface charge with irradiation dose and possible effect of different processing methods.

Primary author: FADEYEV, Vitaliy (University of California,Santa Cruz (US))

Co-authors: PELLEGRINI, Giulio (Centro Nacional de Microelectrónica (IMB-CNM-CSIC) (ES)); SADROZINSKI, Hartmut (SCIPP, UC santa Cruz)

Presenter: PELLEGRINI, Giulio (Centro Nacional de Microelectrónica (IMB-CNM-CSIC) (ES))

Session Classification: Session

Contribution ID: **35** Type: **not specified**

Electric field measurement in irradiated silicon sensors by means of simulations and beam tests [Skype presentation]

Thursday, 12 June 2014 11:40 (20 minutes)

Beam test data and simulations can make accessible the electric field profile of silicon sensors. Different bulk materials, irradiation and annealing scenarios can be contrasted thanks to the charge profile technique (e.g.: T. Lari and C. Troncon, IEEE TNS, VOL. 53, NO. 5, OCTOBER 2006; V. Chiochia, IEEE TNS, VOL. 52, NO. 4, AUGUST 2005) High pointing resolution telescopes and detailed TCAD simulations are needed to complete this task. We will present the project for beam tests and simulations campaigns. In particular we will give all the organization details about the upcoming beamtest at SPS; moreover we will look for groups interested in measuring their samples on beam.

Primary authors: Mr RUBINSKIY, Igor (DESY); BOMBEN, Marco (Centre National de la Recherche Scientifique (FR))

Presenters: Mr RUBINSKIY, Igor (DESY); BOMBEN, Marco (Centre National de la Recherche Scientifique (FR))

Session Classification: Session 3 - TCAD simulations

Contribution ID: **36** Type: **not specified**

Discussion Session: Simulations and Sensor Characterizations

Thursday, 12 June 2014 12:20 (40 minutes)

Session Classification: Session 3 - TCAD simulations

Contribution ID: **37** Type: **not specified**

Impact of Low-Dose Electron Irradiation on the Charge Collection of n+p Silicon Strip Sensors

Thursday, 12 June 2014 12:00 (20 minutes)

The response of p+n strip sensors to electrons from a 90Sr source was measured using the ALiBaVa read-out system. Sensors before hadron irradiation and after a mixed irradiation with 15 1014 1 MeV neq/cm2 23 GeV protons plus 6 1014 1 MeV neq/cm2 reactor neutrons have been investigated. The measurements were performed over a period of several weeks, during which a number of operating conditions were varied. The sensors were fabricated by Hamamatsu on 200 μm thick float-zone silicon. Their pitch is 80 μm, and both p-stop and p-spray isolation of the p+n strips were studied. The electrons from the 90Sr source were collimated to a spot with a full-width-at-half maximum of 2 mm at the sensor and the dose rate at the maximum in the SiO2 was about 0.6 mGy/s. The estimated dose at the end of the measurements was about 1 kGy in SiO2. As function of 90Sr irradiation dose significant changes in charge collection and charge sharing are observed. The effects are significantly larger for the sensors without hadron irradiation. Annealing studies with temperatures up to 80℃ have shown that the observed changes are only partially reversed. The observations are qualitatively explained with the help of TCAD simulations. The relevance of the measurements for the design and the use of p+n strip sensors in different radiation environments are discussed.

Primary authors: JUNKES, Alexandra (Hamburg University (DE)); POEHLSEN, Thomas (University of Hamburg)

Co-authors: GARUTTI, Erika (DESY); Dr STEINBRUECK, Georg (Hamburg University (DE)); ERFLE, Joachim (Hamburg University (DE)); SCHWANDT, Joern (Uni Hamburg); Prof. KLANNER, Robert (Hamburg University (DE))

Presenter: POEHLSEN, Thomas (University of Hamburg)

Session Classification: Session 3 - TCAD simulations

Contribution ID: **38** Type: **not specified**

Workshop opening

Wednesday, 11 June 2014 09:00 (5 minutes)

Presenter: Dr ENCULESCU, Ionut (Director of NIMP, Bucharest)

Session Classification: Session 1 - Defect and Material Characterization